

SRB CRITICAL ITEMS LIST

SUBSYSTEM: SEPARATION

ITEM NAME: Separation Bolt, Forward

PART NO.: 10301-0001-801

FM CODE: A02

ITEM CODE: 30-03-02

REVISION: Basic

CRITICALITY CATEGORY: 1

REACTION TIME: Immediate

NO. REQUIRED: 1

DATE: March 31, 1998

CRITICAL PHASES: Separation

SUPERCEDES: March 31, 1997

FMEA PAGE NO.: B-47

ANALYST: V. Patel

SHEET 1 OF 5

APPROVED: P. Kalia

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FAILURE MODE AND CAUSES: Fails to separate or rupture of bolt housing caused by:

- o Ruptured firing chamber
- o Gaps between mechanical interfaces
- o Failed insert threads
- o Cartridge blowout
- o Undersize fracture groove (housing material too thick)
- o Improper material
- o Improper material heat treat
- o Corrosion
- o Jamming of internal parts
- o Lead extrusion or voids in the lead
- o Improper fracture groove
- o Cracked fracture groove

FAILURE EFFECT SUMMARY: Loss of mission, vehicle and crew due to SRB impacting ET leading to fire and explosion.

RATIONALE FOR RETENTION:

A. DESIGN

- o Design specification USBI 10SPC-0025
 - Materials are selected in accordance with JSC SE-R-0006, MSFC-SPEC- 522A, MIL-S-8844, MIL-S-5000 and MIL-S-46850 per paragraphs 3.1.1, 3.1.1.6, 3.2.3.1, 3.2.3.2 and 3.2.3.3. (Improper Material)
 - Heat treat of the housing and internal component steel is controlled by MIL-H-6875 per para. 3.2.3.1, 3.2.3.2 and 3.2.3.3.

- The bolt shall be capable of operating under a static axial limit tension load of 189,000 pounds and a limit bending moment of 55,344 inch-pounds per paragraph 3.3.1. (Improper Fracture Groove)
 - The bolt shall meet an overall minimum safety factor of 1.1 on yield strength and 1.4 on ultimate strength per paragraph 3.3.1. (Improper Fracture Groove)
 - The bolt shall have a firing chamber safety factor of 1.5 and the safety factor on Ultimate Strength on the fracture groove shall not be less than 1.34 per paragraph 3.3.1. (Improper Fracture Groove)
(BI-1673)
 - Nickel plating per MIL-STD-868, Type I or MIL-C-26074 Class 2 per paragraph 3.1.1.9. (Corrosion)
- o Qualification
- Function Test at High (+120°F) and Low (-10°F) Temperature. (All Failure Causes)
 - Function test at -10°F with one pressure cartridge loaded with 85 percent by weight of the minimum charge load. (All Failure Causes)
 - Failure load test to demonstrate design loads. (Undersized Fracture Groove, Improper Material, Improper Heat Treat)
- o Qualification of design is documented in Hi-Shear test report QTR 9362793-1364.

B. TESTING

- o Lot acceptance test is conducted per Hi-Shear acceptance test procedure ATP 9362793-1102.
- X-ray examination of entire lot of separation bolts. (Cracked Failure Groove and Defective Material)
 - Hardness test of all housings per the above and ICS 9362793-1104 and dissecting of critical areas per the above and 9362793-1071. (Improper Heat Treat/Corrosion)
 - Function test 10 percent of the lot. (Ambient Temperature)
- o Bolt housing lot acceptance test is conducted per Hi-Shear test procedure 9362793-940.
- Ultimate load test (Undersized Fracture Groove, Improper Material Heat Treat)

- Independent Chemical Analysis on one sample from each lot of housing material. (Defective Material)
- Ultrasonic inspection of each bar of housing material. (Defective Material)
- Tensile Test of a minimum of three heat treated bar specimens. (Defective Material and Improper Heat Treatment)
- Hardness test 100% of the housings. (Improper Heat Treatment)
- Groove determination of six housings per lot. (Improper Fracture Groove)
- Magnetic particle inspection 100% of the Bolt Housings before and after proof load. (Cracked Fracture Groove)

C. INSPECTION

The following inspections are performed.

VENDOR RELATED INSPECTION

- o Receiving Inspection. Raw material certification test reports and heat treatment data are verified one hundred percent per: (Defective Material and Improper Heat Treat)
 - Major bolt dimensions, major internal components dimensions, all threads and fracture groove and O-rings are inspected one hundred percent by Contractor Quality Assurance and verified by USBI Quality Assurance per: (Gaps between Mechanical Interfaces, Failed Insert Threads)
 - USBI Quality Assurance.
 - o USBI Source Inspection Plan (SIP) 1118.
 - Contractor Quality Assurance
 - o Hi-Shear Corporation Inspection Check Sheet 9362793-1104
- o Lot Acceptance Test. X-ray film is examined by certified vendor personnel and verified by USBI personnel. Groove determination, ultimate load test and magnetic particle inspection on housing are witnessed one hundred percent (All Failure Causes)
 - USBI Quality Assurance
 - USBI Source Inspection Plan (SIP) 1118.
 - Contractor Quality Assurance
 - Hi-Shear Corporation Assembly Operation Sheet 9362793-3 and Acceptance test procedure 9362793-940
- o Lot review and certification per USBI plan 10PLN-0040.

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- o Critical Processes/Inspections/Operations: The following critical processes, inspections and operations are used to assure structural integrity of the Forward Separation Bolt.
 - X-ray per HSC ATP 9362793-1102. (Gaps and Voids)
 - Ultrasonic Inspection per MIL-STD-2154. (Improper Material)
 - Heat treatment per HSC ATP 9362793-940, HSC 9362793-1078 and HSC 9362793-1140. (Improper Heat Treat)
 - Magnetic Particle Inspection per ASTM-E-1444. (Ruptured Chamber and Improper Material)
 - Nickel Plating per HSC 9362793-1445. (Corrosion)
 - Groove determination per HSC ATP 9362793-940. (Undersize Fracture Groove)

KSC RELATED INSPECTION

- o Receiving Inspection
 - Each forward separation bolt's nickel coating is inspected for blisters, pits, scrapes, nicks or gouges per OMRSD File II, Volume I, requirement number S00HBO.020-B. (Corrosion)
 - Thread checks on NSI pressure cartridge mating threads are performed per OMRSD File V, Volume I, requirement number B000FL.001. (Cartridge Blowout)
 - Verify visual inspection of forward separation bolt per OMRSD File V, Vol. I requirement number B000FL.005. (Corrosion)
 - Verify that the forward separation bolt received has been flight certified by MSFC as required by NSTS 08060 per OMRSD File V, Volume I, requirement no. B000FL.002. (All Failure Causes)
- o Installation Inspection
 - Installation of the forward separation bolt is witnessed by SPC Quality Assurance per OMRSD File II, Vol. I requirement no. S00HBO.020. (Corrosion)

D. FAILURE HISTORY

- o Failure Histories may be obtained from the PRACA database.

E. OPERATIONAL USE

- o Not applicable to this failure mode.

F. WAIVER(S)

- o BI-1673, Dated 08-08-88; Level II Approval; PRCBD S95023

Requirement(s):

NSTS 08060 para. 3.6.18.1 all components exposed to operating pressure shall be capable of withstanding...an internal burst pressure (1.5 times operating pressure) without structural failure.

Departure:

Test assembly ejected end fitting from housing at a pressure of 28,000 psi. which demonstrated a safety factor below 1.5. Test demonstrates a safety factor of 1.379.

Rationale:

Since ejection of a retainer is a concern only at the thread end of the bolt (head of bolt has much thicker material), the bolt assembly's capability to separate is not affected. Controls are in place to ensure that the bolts' operating pressure does not approach the burst pressure. It is therefore recommended that the forward separation bolt be used for flight as is.